

CLAIMS

1. An inhaler, comprising a housing having an outlet and an air inlet, the housing containing: liquid supply means comprising: a chamber providing a reservoir for liquid providing an active ingredient to be supplied to a user and means for supplying liquid from the reservoir to a liquid outlet; and

means for creating an electric field for causing comminution of liquid issuing from the liquid supplying means outlet in response to air flowing through the air inlet so as to produce a stream of electrically charged comminuted matter for supply to the nasal passages of the housing outlet.

2. An inhaler according to claim 1, wherein the liquid supplying means has first and second outlets; and the electric field creating means comprises a first electrohydrodynamic comminution means for subjecting liquid issuing from the first outlet to an electrical potential to cause the liquid to be comminuted to form a comminution of one polarity; and a second electrohydrodynamic comminution means for subjecting liquid issuing from the second outlet to an electrical

potential to cause the liquid to be comminuted to form a
comminution of the opposite polarity, means being
provided for providing an air flow to the outlet to
modify any mixing of the two opposite polarity
5 comminutions.

3. An inhaler according to claim 1, wherein the
electric field creating means comprises first and second
spaced apart electrodes with the first electrode being
10 provided at or adjacent the outlet of the liquid
supplying means; and voltage supplying means operable in
response to air flowing through the air inlet to provide
a potential difference between the first and second
electrodes.

4. An inhaler according to claim 3, wherein the voltage
supplying means comprises an air flow activated switch
for coupling a voltage generating means across the first
and second electrodes.

5. An inhaler according to claim 3, wherein the air
flow activated switch comprises a closure member and
spring biasing means normally biasing the closure
member into a position closing off the supply of air into

the housing through the air inlet, the closure member being movable against the spring biasing to a position allowing air to flow into the housing through the air inlet in response to the air flow.

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6. An inhaler according to claim 1, 2, 3, 4 or 5, wherein the housing is arranged to enable a user to create the air flow by breathing in through the housing outlet.

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7. An inhaler according to any one of the preceding claims, comprising a pump for creating the air flow.

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8. An inhaler, comprising a housing having an outlet, the housing containing: a chamber providing a reservoir for liquid providing an active ingredient to be supplied to a user; means for supplying liquid from the reservoir to a liquid outlet; first and second spaced apart electrodes with the first electrode being provided at or adjacent the outlet of the liquid supplying means; and user-operable voltage supplying means for providing a potential difference between the first and second electrodes to create an electric field for causing comminution of liquid issuing from the liquid supplying

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means outlet to produce a stream of electrically charged
comminuted matter, the first and second electrodes being
spaced from the housing outlet and being arranged so as
to provide, when a potential difference is applied across
5 them by the voltage supplying means, an electric field
which reduces rapidly in the direction of liquid flow
from the liquid supplying means and the housing having an
air flow path to the housing outlet for causing liquid
comminuted by the electric field to be entrained by the
10 air flow for supply via the housing outlet to the nasal
passages of a user.

9. An inhaler according to any one of claims 3, 5 or 8
or claims 6 and 7 when dependent on claim 3, wherein the
15 first and second electrodes are spaced apart in a
direction perpendicular to the flow of liquid from the
liquid supplying means.

10. An inhaler according to any one of claims 3, 5, 8 or
20 9 or claims 6 and 7 when dependent on claim 3, wherein
the second electrode is located downstream of the supply
of liquid from the liquid outlet.

11. An inhaler, comprising a housing having an outlet,

the housing containing: a chamber providing a reservoir for liquid providing an active ingredient to be supplied to a user; means for supplying liquid from the reservoir to a liquid outlet; first and second spaced apart electrodes with the first electrode being provided at or adjacent the outlet of the liquid supplying means; and user-operable voltage supplying means for providing a potential difference between the first and second electrodes to create an electric field for causing comminution of liquid issuing from the liquid supplying means outlet to produce a stream of electrically charged comminuted matter for supply via the housing outlet to the nasal passages of a user, wherein current-limiting means are provided for limiting the supply of current by the voltage supplying means.

12. An inhaler according to any one of claims 3, 5 or 8 or claims 6 and 7 when dependent on claim 3, wherein current-limiting means is associated with one of the first and second electrodes.

13. An inhaler according to claim 11 or 12, wherein the current-limiting means comprises a dielectric or semi-insulating coating or sleeve provided on said one of the

first and second electrodes.

14. An inhaler according to claim 8, 9 or 10, wherein the voltage supplying means comprises an air flow activated switch for coupling a voltage generating means across the first and second electrodes.

15. An inhaler according to claim 14, wherein the air flow activated switch comprises a closure member and spring biasing means normally biasing the closure member into a position closing off the supply of air into the housing through the air inlet, the closure member being movable against the spring biasing to a position allowing air to flow into the housing through the air inlet in response to a user breathing in through the housing outlet or in response to an air supply to the air inlet.

16. An inhaler according to any one of claims 3, 5, 8 to 15 or 6 and 7 when dependent on claim 3, wherein the voltage supplying means comprises a further electrode positioned adjacent the second electrode and resistive means coupling the second electrode to earth, the voltage supplying means being arranged to cause the further electrode to generate an ion current for charging the second electrode to an electrical potential sufficient to

provide the electrical potential for causing comminution of liquid issuing from the outlet.

17. An inhaler, comprising a housing having an outlet and an air inlet, the housing containing: a chamber providing a reservoir for liquid providing an active ingredient to be supplied to a user; means for supplying liquid from the reservoir to a liquid outlet; means for creating an electric field for causing comminution of liquid issuing from the liquid supplying means outlet; and means for providing a flow of air towards the housing outlet so as to produce a stream of electrically charged comminuted matter for supply to the nasal passages of a user via the housing outlet.

18. An inhaler, comprising a housing having an outlet and an air inlet, the housing containing: a chamber providing a reservoir for liquid providing an active ingredient to be supplied to a user; means for supplying liquid from the reservoir to a liquid outlet; means for creating an electric field for causing comminution of liquid issuing from the liquid supplying means outlet; and means for shearing comminuted matter issuing from the liquid outlet to produce a stream of electrically charged comminuted matter of smaller size than that produced by the electric field for supply to the nasal passages of a user via the housing outlet.

19. An inhaler according to claim 18, wherein the shearing means comprises means for producing air flow in

the vicinity of liquid issuing from the liquid outlet.

20. An inhaler comprising a housing having an outlet and an air inlet, the housing containing means for supplying liquid to first and second outlets; a first electrohydrodynamic comminution means for subjecting liquid issuing from the first outlet to an electrical potential to cause the liquid to be comminuted to form a comminution of one polarity; a second electrohydrodynamic comminution means for subjecting liquid issuing from the second outlet to an electrical potential to cause the liquid to be comminuted to form a comminution of the opposite polarity; and means for providing an air flow to the outlet to modify any mixing of the two opposite polarity comminutions.

21. An inhaler according to claim 2 or 20, wherein the air flow providing means is operable to keep the two opposite polarity comminutions apart.

22. An inhaler according to claim 2, 20 or 21, further comprising means for controlling at least one of: 1) the relative flow rates of liquid to the first and second liquid outlets; 2) the relative electrical potentials to which liquid issuing from the first and second outlets is subjected; and 3) the air flow provided by the air flow providing means.

23. An inhaler according to claim 2, 20, 21 or 22, comprising a respective reservoir for each liquid outlet

the reservoirs containing different liquids.

24. An inhaler according to any one of claims 2, 20, 21, 22 or 23, wherein the first and second liquid outlets are angled towards one another.

25. An inhaler according to any one of the preceding claims, further comprising air flow control valve means for controlling air flow.

26. An inhaler comprising means for supplying liquid to a liquid outlet, voltage supply means for subjecting liquid issuing from the liquid outlet to an electric field for causing comminution of liquid issuing from the outlet, and means for controlling the size of the components, for example droplets, of the comminuted matter.

27. An inhaler comprising means for supplying liquid to a liquid outlet, voltage supplying means for subjecting liquid issuing from the liquid outlet to an electric field for causing comminution of liquid issuing from the outlet, and means for controlling the size of the comminuted matter such that the comminuted matter has at least two different controlled sizes.

28. An inhaler comprising means for supplying liquid to a liquid outlet, voltage supplying means for subjecting liquid issuing from the liquid outlet to an electric field for causing comminution of liquid issuing from the

outlet to produce a spray of droplets, and means for controlling the diameter of the droplets so that the comminuted matter consists of droplets each having one of at least two different controlled diameters.

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29. An inhaler according to claim 21, 22 or 23, wherein the controlling means comprises means for superimposing on the voltage supplied by the voltage supplying means an alternating or pulsed signal.

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30. An inhaler according to claim 22 or 23, wherein the controlling means comprises means for superimposing on the voltage supplied by the voltage supplying means a signal having two different frequency components for causing the comminuted matter to contain two different sizes of components.

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31. An inhaler according to claim 29 or 30, wherein the superimposing means is arranged to superimpose on the voltage supplied by said voltage supplying means a signal having three or more different frequency components for causing the comminuted matter to contain three or more different sizes of components.

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32. An inhaler according to claim 30 or 31, wherein said signal is arranged to consist of said frequency components superimposed simultaneously on said voltage in phase with one another.

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33. A device according to claim 30 or 31, wherein said

signal is arranged such that said different frequency components are superimposed one after another on said voltage.

5 34. An inhaler according to any one of claims 25 to 32, wherein the means for controlling the size of the components of the comminution comprises means for regulating the liquid flow and/or the liquid composition.

10 35. An inhaler according to any one of claims 25 to 34, wherein the means for controlling the size of the comminution components comprises a plurality of subsidiary liquid outlets which together form the liquid outlet and respective different cross-section supply
15 pipes for supplying liquid to each different one of the subsidiary liquid outlets.

36. An inhaler according to any one of claims 25 to 35, wherein the means for controlling the size of the
20 comminution components comprises a plurality of subsidiary liquid outlets which together form the liquid outlet each having a respective valve means for controlling the liquid flow from the outlet.

25 37. An inhaler according to any one of the preceding claims, having a respective housing outlet for each nostril of a user or patient.

30 38. An inhaler according to any combination of the preceding claims.

39. An inhaler according to any one of the preceding claims, wherein the air flow is induced other than by inhalation.

5 40. An inhaler according to any one of the preceding claims, comprising a biologically acceptable carrier for the active ingredients selected from: an oil, an alcohol, a polymer or a water-based solvent.

10 41. An inhaler according to any one of the preceding claims, comprising a supply of liquid carrying as an active ingredient at least one of the following: a decongestant, a lipid, a vitamin, an antiseptic, an anti-inflammatory, an antibiotic, an anti-cancer agent, a
15 vaccine, a protein, an enzyme, a bioadhesive, DNA or DNA fragments, nicotine and morphine.

42. A liquid formulation for use in an inhaler in accordance with any one of claims 1 to 38, comprising a
20 biologically acceptable carrier liquid for an active ingredient and a polymer.

43. A liquid formulation for use in an inhaler in accordance with any one of claims 1 to 38, comprising a
25 biologically acceptable carrier liquid for an active ingredient and a medium to high molecular weight polymer.

44. A liquid formulation for use in an inhaler in accordance with any one of claims 1 to 38, comprising a
30 biologically acceptable carrier liquid for an active

ingredient and a medium to high molecular weight polymer such as PVA or PVP.

5 45. A liquid formulation for use in an inhaler in accordance with any one of claims 1 to 38, comprising a biologically acceptable carrier liquid for an active ingredient and an amount of a polymer selected from amongst the following: 0.2 to 0.7 grammes per 10 centilitres of formulation of PVA; 0.2 grammes per 10 centilitres of formulation of PVA; from 0.2 to 1.2 grammes per 10 centilitres of formulation of PVP; or 0.5 grammes per 10 centilitres of formulation of PVP.

15 46. A liquid formulation according to claim 42, 43, 44 or 45, further comprising as an active ingredient at least one of the following: a decongestant, a lipid, a vitamin, an antiseptic, an anti-inflammatory, an antibiotic, an anti-cancer agent, a vaccine, a protein, an enzyme, a bioadhesive, DNA or DNA fragments, nicotine and morphine.

25 47. A method of controlling the geometry or shape of comminuted matter produced by electrohydrodynamic comminution of at least one liquid, which method comprises controlling the geometry or shape by controlling or adjusting the amount of at least one medium to high weight polymer in the or at least one of the liquids.

30 48. A method of controlling the geometry or shape of

comminuted matter produced by electrohydrodynamic
comminution of at least one liquid, which method
comprises controlling the geometry or shape by
controlling or adjusting the amount of PVA or PVP in the
5 or at least one of the liquids.

49. A method of controlling the geometry or shape of
comminuted matter produced by electrohydrodynamic
comminution of at least one liquid, which method
10 comprises controlling the geometry or shape by adding
sufficient polymer to the liquid to cause at least some
of the comminuted matter to have a granular form with at
least some of the granules having fibrils or tails.

50. A method according to any one of claims 47 to 49,
15 wherein the liquid comprises water and an alcohol.

51. Use of an oil-based formulation as a carrier for an
active ingredient to be delivered to a user or patient as
20 comminuted matter formed by electrohydrodynamic
comminution of the formulation.

52. A dispensing device having liquid supply means for
supplying liquid to a liquid outlet means and means for
25 subjecting liquid issuing from the liquid outlet means to
an electric field to cause electrohydrodynamic
comminution of the liquid, wherein the liquid supply
means comprises a supply of liquid in the form of an oil-
based formulation carrying an active ingredient.

53. A nasal inhaler having a housing containing liquid supply means for supplying liquid to a liquid outlet means and means for subjecting liquid issuing from the liquid outlet means to an electric field to cause electrohydrodynamic comminution of the liquid to provide comminuted matter to an outlet of the housing for inhalation by a user or patient, wherein the liquid supply means comprises a supply of liquid in the form of an oil-based formulation carrying an active ingredient.

54. A delivery device having the features of the inhaler described in any one of the preceding claims but differing in that the device is arranged to supply the active ingredient to the mouth, an eye or a bodily orifice and in that air flow is induced other than by inhalation or alternatively by oral inhalation when the device is arranged to supply the active ingredient to or via the mouth.

55. A method of supplying an active ingredient to the nasal passages of a human or animal which comprises using an inhaler in accordance with any one of claims 1 to 41.

56. A method of supplying an active ingredient to an eye or bodily orifice other than the mouth or nose which comprises using a delivery device in accordance with claim 54.